

Short communication

A Newly Recorded Sea Star of the Genus *Marginaster* (Asteroidea: Valvatida: Poraniidae) from the Korea Strait, Korea

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ABSTRACT

A sea star was collected from the Korea Strait in the waters adjacent to eastern Jeju Island, Korea (33°39'86"N, 127°33'12"E) at a depth of 92 m on November 5, 2016. This specimen was identified as *Marginaster paucispinus* Fisher, 1913, from the family Poraniidae of the order Valvatida, based on morphological characteristics. The genus *Marginaster* Perrier, 1881 and *M. paucispinus*, which were first reported in the South China Sea, are new to the Korean fauna. Partial sequences of mitochondrial COI and 16S ribosomal RNA of *M. paucispinus* were have been determined for the first time and were deposited in GenBank. They are the first molecular records for the genus *Marginaster*.

Keywords: sea star, *Marginaster*, Korea, taxonomy, mitochondrial COI, 16S ribosomal RNA, molecular identification

INTRODUCTION

The poorly studied family Poraniidae from the order Valvatida is distributed throughout the Atlantic, Indian, Pacific, and Southern Oceans (Clark, 1984, 1993). Recently, the classification of this group has been revised based on morphological and molecular phylogenetic data (Mah and Foltz, 2014). Mah and Foltz (2014) presented two new genera, *Bathyporania* and *Clavaporania*, and genus *Culcitopsis* was reinstated to genus level which is the previously synonymized genus *Glabraster*. Therefore, the family Poraniidae comprises 11 genera: *Bathyporania* Mah and Foltz, 2014; *Chondraster* Verrill, 1895; *Clavaporania* Mah and Foltz, 2014; *Culcitopsis* Verrill, 1914; *Glabraster* Clark, 1916; *Marginaster* Perrier, 1881; *Porania* Gray, 1840; *Poraniomorpha* Danielssen and Koren, 1881; *Poraniopsis* Perrier, 1891; *Spoladaster* Fisher, 1940; *Tylaster* Danielssen and Koren, 1881 (see Mah and Foltz, 2014; Mah, 2017), of which only the genus *Poraniopsis* has been reported in Korean waters until now (Shin and Rho, 1996; Shin, 2010).

The genus *Marginaster* is known only from small specimens ($R < 20$ mm) among the Poraniidae (Clark, 1984) and comprises only four species (Mah, 2017). Verrill (1914) questioned the status of *M. pectinatus*, a type species of the genus *Marginaster*, and argued that it was probably a young specimen of *Porania* or some other similar genus. However, Downey (1973) found sexually mature specimens of *Marginaster* from the West Indies. Two species of *Marginaster* have been synonymized to species of another genus (Clark, 1984; Clark and Downey, 1992). Accordingly, species identification of the genus *Marginaster* requires careful consideration.

On November 5, 2016, a sea star was collected with a trawl net at a depth of 92 m in waters of the Korea Strait, adjacent to eastern side of Jeju Island, Korea. The collected specimen was preserved in 95% ethyl alcohol and deposited in the Marine Echinoderm Resource Bank of Korea (MERBK), Sahmyook University, Seoul, Korea. Its important morphological characteristics were photographed using a digital camera (G12; Canon, Tokyo, Japan) and stereo mi-

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Table 1. Primers used in this study

Primer name	Primer sequence (5'-3')	References
COIceF	ACTGCCAACGCCCTAGTAATGATATTGTTATGGTNATGCC	Hoareau and Boissin (2010)
COIceR	TCGTGTGTCTACGTCCATTCTACTGTRAACATRTG	
16sar-L	CGCCTGTTATCAAAACAT	Palumbi et al. (1991)
16sbr-L	CCGGTCTGAACTCAGATCACGT	

croscope (Nikon SMZ 1000; Tokyo, Japan). Identification and morphological description of the specimen followed the traditional taxonomic characters described by Fisher (1919) and Clark and Downey (1992). Total genomic DNA was extracted from gonadal tissue following the DNeasy kit protocol (Qiagen, Hilden, Germany). Partial sequences of the mitochondrial (mt) cytochrome oxidase I (COI) and 16S ribosomal RNA gene were amplified using pairs of primers conserved in echinoderms (Table 1). PCR amplification reactions were performed according to Lee and Shin (2011). PCR product quality was assessed using a NanoDrop 1000 (Thermo Fisher Scientific, Waltham, MA, USA), and PCR products were sequenced using Big Dye Terminator kits (Applied Biosystems, Foster City, CA, USA) on a 3730XL DNA Analyzer (Applied Biosystems).

Poraniopsis inflata is the only species from the family Poraniidae recorded from the East Sea of Korea (Shin and Rho, 1996; Shin, 2010). *Marginaster paucispinus* is the new genus and species record in the fauna of Korea. The two genera and the species are recorded in Korea, and a key for the Korean Poraniid genera was prepared.

SYSTEMATIC ACCOUNTS

Class Asteroidea de Blainville, 1830

Order Valvatida Perrier, 1884

Family Poraniidae Perrier, 1893

Key to the genera of the family Poraniidae in Korea

1. Inferomarginal plates with spines, single papula present on the abactinal side *Marginaster*
– Inferomarginal plates without spines, clustered papulae present on the abactinal side *Poraniopsis*

^{1*}Genus *Marginaster* Perrier, 1881

Marginaster Perrier, 1881: 16; 1894: 164; Sladen, 1889: 364; Verrill, 1914: 18; Fisher, 1919: 407; Clark, 1984: 25; Clark and Downey, 1992: 204; Rowe and Gates, 1995: 108; Mah, 2017: 123319.

Poranisca Verrill, 1914: 19; Clark, 1984: 25.

Type species: *Marginaster pectinatus* Perrier, 1881

Body nearly pentagonal, small, R usually under 20 mm. Abactinal plates covered with skin and spines. Inferomarginal plates project to form a margin, each plate with five spines forming a marginal edge.

^{2*}*Marginaster paucispinus* Fisher, 1913

Marginaster paucispinus Fisher, 1913: 216; 1919: 407; Lane et al., 2000: 474; Mah, 2017: 381976.

Material examined. One specimen, 33°39'86"N, 127°33'12"E, Korea Strait near eastern part of Jeju Island, Korea, 5 Nov 2016, at 92 m depth with a trawl net.

Description. Body small, flat, nearly stellate-pentagonal in form. Actinal side flattened, abactinal surface covered with skin. Arms short, tapering to a blunt straight tip (Fig. 1A–C). Abactinal skeletons obscured by skin, reticulate and abactinal plates around disk center rounded, one to four club-shaped short spines on each plate (Fig. 1D). Madreporite small, flat, circular, with irregular grooves, slightly higher than abactinal surface (Fig. 1E). Anus small, covered with club-shaped short spines (Fig. 1F). Actinal plates form transverse rows from adambulacral plates to inferomarginal plates (Fig. 1G, H). Inferomarginal plates flat, wider than long (largest plate: length = 0.9 mm, width = 1.9 mm), slightly spaced, with five or six digital webbed spines (length 0.18–0.24 mm) (Fig. 1I). Adambulacral plates with two webbed digitiform spines, two furrow spines on first five plates, but one spine on subsequent plates (Fig. 1J). Oral plate narrow, with four spines and two suboral spines (Fig. 1K).

Size. R = 16 mm, r = 10 mm, R = 1.6 r.

Color. Body is light reddish brown in the living animal.

Distribution. Korea (Korea Strait), South China Sea.

Remarks. *Marginaster paucispinus* is one of the rarest sea stars in the world and the only species of *Marginaster* in the North Pacific (Fisher, 1913, 1919). *M. paucispinus* was the only species of the genus found in the Pacific region before McKnight (2006) reported *M. patriciae* in the adjacent water of New Zealand. A few specimens were collected in previous studies at a depth of around 180 m in the South China

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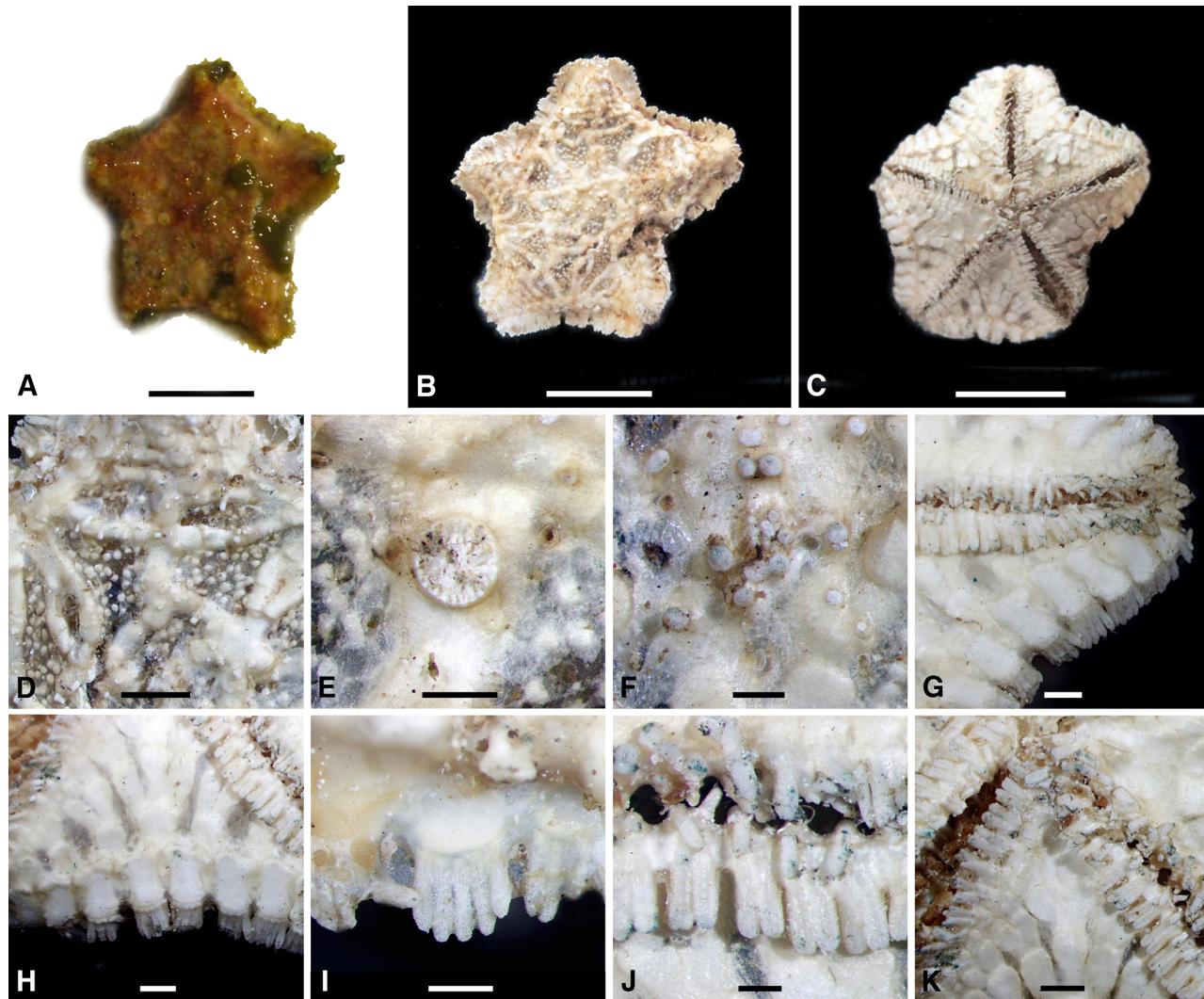


Fig. 1. *Marginaster paucispinus*. A, Abactinal view of a living specimen; B, Abactinal view of alcohol-preserved specimen; C, Actinal view of alcohol-preserved specimen; D, Abactinal plates; E, Madreporite; F, Anus and abactinal spines; G, Actinal side of the arm; H, Actinal plates and inferom marginal plates; I, Spines of the inferom marginal plate; J, Spines of adambulacrals plates; K, Actinal part. Scale bars: A-C=1.0 cm, D, E, G, H, J=1 mm, F, I=0.5 mm, K=2 mm.

Sea (Fisher, 1913; Lane et al., 2000). Our specimen differs in two morphological characteristics from the original description by Fisher (1913): the number of adambulacrals plate with two furrow spines (Fisher: 2, Korean specimen: 5) and the number of spines on inferom marginal plate (Fisher: 4 or 5, Korean specimen: 5 or 6). Several previously described species of *Marginaster* were either juveniles of other poraniids or members of other taxa (Clark, 1984; Clark and Downey, 1992). Therefore, nominal species and description of new taxa should be carefully interpreted (Mah, 2017). Korean specimen of *M. paucispinus* was sexually mature, which specimen has fully matured gonad. Accordingly, we accomplished genomic DNA extraction from gonad tissue.

The partial sequences of the mt COI (644 bp) and 16S rRNA (604 bp) are deposited in GenBank under accession numbers MF599201 (COI) and MF599200 (16S rRNA). These sequences are the first to be deposited in GenBank from the genus *Marginaster*.

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REFERENCES

Clark AM, 1984. Notes on Atlantic and other Asteroidea. 4. Families Poraniidae and Asteropseidae. Bulletin of the British Museum of Natural History (Zoology), 47:19-51.

Clark AM, 1993. An index of names of recent Asteroidea. Part 2. Valvatida. In: Echinoderm studies Vol. 4 (Eds., Jangoux M, Lawrence JM). A.A. Balkema, Rotterdam, pp. 187-366.

Clark AM, Downey ME, 1992. Starfishes of the Atlantic. Natural History Museum and Chapman Hall, London, pp. 1-794.

Downey ME, 1973. Starfishes from the Caribbean and the Gulf of Mexico. Smithsonian Contributions to Zoology, 126:1-158. <https://doi.org/10.5479/si.00810282.126>

Fisher WK, 1913. New starfishes from the Philippine Islands, Celebes, and the Moluccas. Proceedings of the United States National Museum, 46:201-224.

Fisher WK, 1919. Starfishes of the Philippine seas and adjacent waters. Bulletin of the United States National Museum, 3:1-712.

Hoareau TB, Boissin E, 2010. Design of phylum-specific hybrid primers for DNA barcoding: addressing the need for efficient COI amplification in the Echinodermata. Molecular Ecology Resources, 10:960-967. <https://doi.org/10.1111/j.1755-0998.2010.02848.x>

Lane DJW, Marsh LM, Vanden Spiegel D, Rowe FWE, 2000. Echinoderm fauna of the South China Sea: an inventory and analysis of distribution patterns. The Raffles Bulletin of Zoology, 8:459-493.

Lee T, Shin S, 2011. A new record of sea urchin (Echinoidea: Camarodonta: Strongylocentrotidae) based on morphological and molecular analysis in Korea. Korean Journal of Systematic Zoology, 27:213-219.

Mah C, 2017. Asteroidea [Internet]. World Register of Marine Species, Accessed 23 Jun 2017, <<http://www.marine-species.org>>.

Mah CL, Foltz DW, 2014. New taxa and taxonomic revisions to the Poraniidae (Valvatacea; Asteroidea) with comments on feeding biology. Zootaxa, 3795:327-372. <https://doi.org/10.11646/zootaxa.3795.3.7>

McKnight DG, 2006. The marine fauna of New Zealand: Echinodermata: Asteroidea (sea-stars). 3. Orders Velatida, Spinulosida, Forcipulatida, Brisingida, with addenda to Paxillosida, Valvatida. National Institute of Water and Atmospheric Research (NIWA) Biodiversity Memoir, 120:1-187.

Palumbi S, Martin A, Romano S, McMillan WO, Stice L, Grabowski G, 1991. The simple fool's guide to PCR. Department of Zoology and Kewalo Marine Laboratory, University of Hawaii, Honolulu, HI, pp. 1-45.

Perrier E, 1881. Description sommaire des espèces nouvelles d'Astéries. Bulletin of the Museum of Comparative Zoology at Harvard College, 9:1-31.

Perrier E, 1894. Échinodermes. Part 1. Stellérides. Expeditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1883. G. Masson, Paris, pp. 1-431.

Rowe FWE, Gates J, 1995. Echinodermata. In: Zoological catalogue of Australia. Vol. 33 (Ed., Wells A). CSIRO, Melbourne, pp. 1-486.

Shin S, 2010. Sea Star: Echinodermata: Asterozoa: Asteroidea. Invertebrate fauna of Korea, Vol. 32, No. 1. National Institute of Biological Resources, Incheon, pp. 1-150.

Shin S, Rho BJ, 1996. Illustrated encyclopedia of fauna and flora of Korea, Vol. 36. Echinodermata. Ministry of Education of Korea, Seoul, pp. 1-780.

Sladen WP, 1889. Report on the Asteroidea collected by H.M.S. "Challenger" during the years 1873-1876, Zoology, 30:1-893.

Verrill AE, 1914. Monograph of the shallow-water starfishes of the North Pacific coast from the Arctic Ocean to California. Harriman Alaska Series of the Smithsonian Institute, 14:1-408. <https://doi.org/10.5962/bhl.title.25926>

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